THE ROLE OF UNIVERSITIES IN THE BRAZILIAN NSDI CAPACITY BUILDING PLAN – THE CASE OF THE OPEN GEOSPATIAL LABORATORY AT UFPR

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Abstract. Since creation of The Brazilian National Spatial Data Infrastructure, in 2008, it has been a challenge to form the qualified workforce to produce and use standardized geospatial data and services. As the International Cartographic Association and the Open Source Geospatial Foundation are promoting the development of an international network of Open Source Geospatial Laboratories, this article describes decisions regarding its establishment at UFPR: target audiences, contents and modalities. The role of Brazilian universities in the NSDI Capacity Building network is also discussed, once the institutions are present in whole territory and can act including local and regional actors to extend and democratize the reach of the initiative.

Keywords: Education and Training, NSDI, Open Geospatial Laboratory

1. Introduction

Recent studies conducted by the Institute of Applied Economic Research (IPEA, 2011) indicate that if Brazil continues to grow economically at the same rates of the last years, the demand for engineers will be such that the higher education institutions will be unable to supply the market demand. The situation, according to the study, seems to be more critical on the mineral extraction industries (oil and gas), construction and infrastructure.

Therefore, the demand for qualified professionals will face challenges in the near future since it will require the expansion of the number of students in higher education institutions, major investments in improving the infrastructure of the undergraduate programs, the improvement of the basic education level of the entrants to higher education and the recognition of teaching career.

According to a data from the Federal Council of Engineering and Agronomy (CONFEA,2012), in 2008 there were 32,000 new engineers in Brazil, which represents 9% of the total number of higher education graduates of that year. This means that the number of engineers on the market was only six for 100 thousand inhabitants. These values are much lower than China and South Korea with 25 engineers per 100 000 inhabitants, and India with 22 engineers per 100 000 inhabitants, for example.

Geospatial information industry also share the same lack of available professionals, which affects planning activities and the sectors of public and private administration involving the environment, agriculture, urban planning, health, education, transport, telecommunications, among others, that are increasingly being supplied by geoinformation market (EMBRAPA, 2006).

Embrapa Satellite Monitoring, in 2006, has already pointed out the positive characteristic of this industry developing together with the Information Technology and Communication (ITC), with a strong network of academic knowledge generation and a consolidated market of companies producing geospatial data. The report also showed that the market was poorly organized regarding the coordination of institutions, companies and industry professionals, and that there is a lack of clear standards and certification procedures for data, as well as an absence of public policies for data production and dissemination to society.

Recent initiatives from the Federal Government stimulate planning and implementation of major infrastructure projects (Accelerated Growth Program in 2007) and the expansion of public higher education, including the reduction of dropout rates and the occupation of unfilled places (REUNI Project in 2007). These projects have directly contributed to the expansion of the geoinformation market, first by ensuring employment opportunities and second, by making an effort to increase the supply of qualified workforce.

In the topic of human resources training and development, according to the 2010 Higher Education Census, conducted by the Ministry of Education (MEC,2012), Brazil has 2,378 high education institutions, which offer 3,120,192 places in 29.507 undergraduate programs (including distance and on-campus education). The results of this census showed a growth of 74% in public institutions enrollment, relative to 2001. The government effort to democratize the education is shown it the distance learning increase, that in 2010 were already 14,6% from total. The technological knowledge areas that were identified with higher increase rates were Management and Business (24,7%), Information Processing (12,3%) and Engineering (7,7%) in the last ten years.

In Engineering degrees, there were an expressive growth in number of programmes, and the field including Geoprocessing, Surveying and Cartography degrees has grown from 12 programs in 1999 to 36 in 2012, offering 2028 places, as shown in *Table 1* bellow (MEC, 2012). Geographically, these institutions are spread in 28 cities in 14 states. The distribution is still concentrated in south, southeast and northeast regions as the map in *Figure 1* shows.

	Program Name	Start Date	State	City	Places
1	CART	26/06/1930	RJ	Rio de Janeiro	30
2	CART	01/03/1996	RS	Porto Alegre	30
3	CART	02/01/1970	PE	Recife	30
4	CART	27/04/1976	RJ	Rio de Janeiro	50
5	CART	05/08/1977	SP	Presidente Prudente	40
6	CART_SURV	28/02/2011	RS	São Leopoldo	100
7	CART_SURV	21/02/2011	MG	Monte Carmelo	60
8	CART_SURV	01/01/1976	PR	Curitiba	44
9	CART_SURV	in progress	PA	Belém	
10	CART_SURV	11/11/2011	RS	Itaqui	50
18	CART_SURV	01/02/2011	MG	Inconfidentes	30
19	CART_SURV	01/03/2010	BA	Salvador	45
20	CART_SURV	13/03/2000	RJ	Seropédica	50
21	CART_SURV	01/03/1976	MG	Viçosa	40
26	GEO	02/02/2011	PA	Belém	200
27	GEO	in progress	MT	Cuiabá	30
28	GEO	01/08/2001	PI	Teresina	40
29	GEO	01/08/2005	GO	Goiânia	60
3	GEO	04/03/2002	PB	João Pessoa	50

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31	GEO	01/08/2010	RS	Pelotas	45
32	GEO	10/08/2009	RS	Santa Maria	40
33	GEO	02/03/2009	SC	Tubarão	22
34	GEO	in progress	RS	Passo Fundo	50
35	GEO	01/08/2010	RS	Santa Cruz do Sul	40
36	GEO	in progress	SP	Campinas	60
11	SURV	05/01/1965	SP	Araraquara	60
12	SURV	14/06/1966	AL	Maceió	30
13	SURV	11/08/1975	SC	Criciúma	50
14	SURV	27/06/1960	BA	Salvador	80
15	SURV	07/04/1972	SP	Piras-sununga	50
16	SURV	29/02/1968	MG	Belo Hori-zonte	150
17	SURV	22/08/1975	PI	Teresina	52
22	SURV (SEQ)	21/05/2004	SP	Piras-sununga	120
23	SURV_TEC	01/08/2008	GO	Goiânia	100
24	SURV_TEC	01/02/2000	GO	Goiânia	60
25	SURV_TEC	05/02/2007	MG	Inconfiden-tes	40
				TOTAL	2028

Table 1: University Programs per City and Places Available. Source: MEC (2012). Abbreviations: CART = Cartographic Engineering, SURV = Surveying Engineering, GEO = Technology in Geoprocessing, SURV_TEC = Technology in Surveying and SURV_CART/CART_SURV = Cartographic and Surveying Engineering

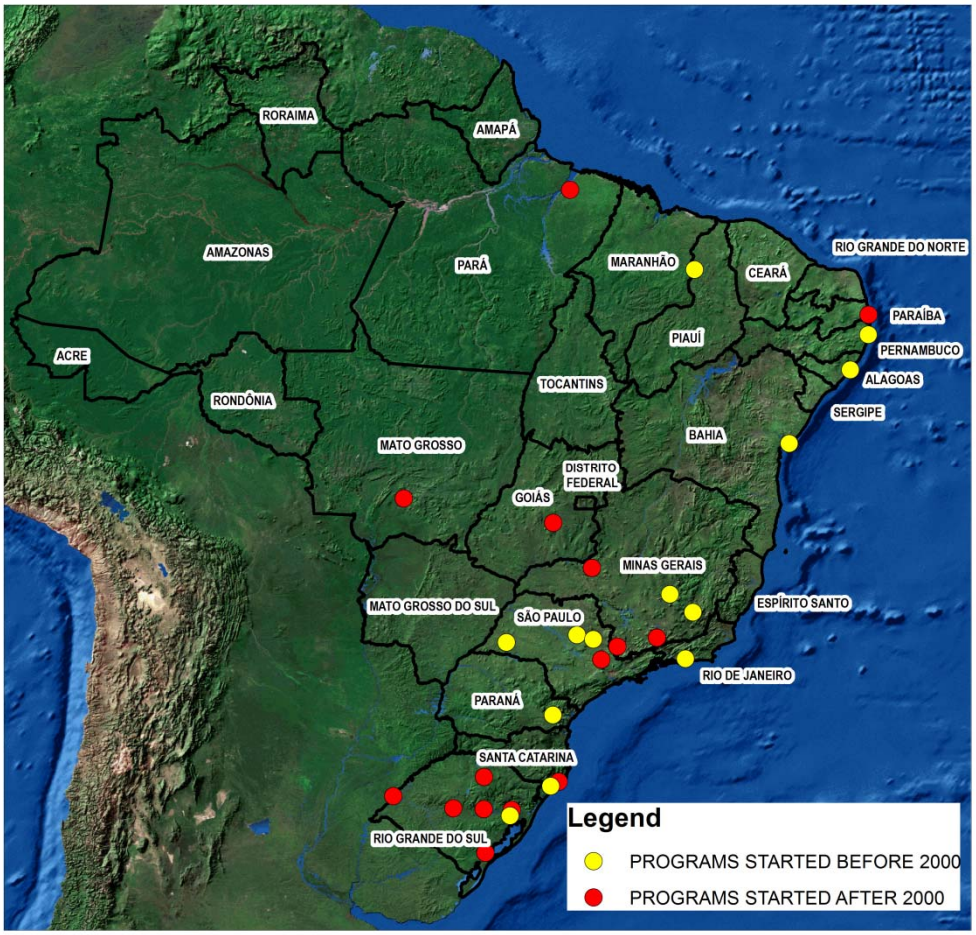

Figure 1: Distribution of Undergraduate Programs in Geoprocessing, Surveying and Cartography in Brazil

Another important governmental initiative concerns the establishment of the National Spatial Data Infrastructure (NSDI) in 2008 with the purpose of providing standardized geospatial data in a simple, complete and integrated manner to a whole range of users and multiple uses.

Thus there seems to be a consensus on the Federal Government about the close relationship between economic development, human resource training through the promotion of quality public education, and adequate geographical knowledge of the territory.

In this paper we focus on the process of establishing an Open Geospatial Laboratory which is part of an international network supported by the International Cartographic Association and the Open Source Geospatial Foundation. The aim of the initiative is the dissemination of open data,

software and standards in the field of geospatial information. This node of the network was created at the Federal University of Paraná (UFPR), the largest university in the state of Paraná, one of the 27 states of Brazil, located in the southern region of the country with about 10 million inhabitants and the 5th largest GDP among Brazilian states (IBGE, 2012).

We describe how the laboratory activities are being structured concerning its content, format and target audience, understanding this as a case study of the integration of Brazilian universities in the training effort for the NSDI in Brazil.

2. Training in SDIs and NSDI-BR

2.1. State of the art of training for SDIs

The first SDIs created since the beginning of the 1990's were primarily focused on data and with efforts most concentrated in the government sphere (Sadegui-Niaraki et al., 2010). Currently the SDIs have increased its importance and the efforts are concentrated to facilitate data access and editing by users. This is a significant paradigm shift from the first SDIs generation toward a more service-oriented management. In this model the concerns are demand-oriented and the solutions focus on interactions among the several actors and society in general (see Bernard and Craglia, 2005; Ferdandez and Castellanos, 2006; Leite Jr et al., 2006; Masser, 2009).

In the SDI Cookbook (Nebert et al., 2004) there is a whole chapter dedicated to Outreach and Capacity Building with many examples relating experiences of several countries and organization in this topic. As the initiatives developed during time, new questions have been raised regarding the importance of training in the coalition construction and institutional strengthening in NSDIs. (Masser, 2007).

Nedović-Budić and Budhathoki (2006) further expanded the concept: more than training, the focus should be shifted to cultivate a cultural and technological base with sufficient flexibility to accommodate local circumstances, since regional SDIs, as in metropolitan areas, are the fundamental elements for the construction of a NSDI.

Other studies also emphasized the importance of training in the local and regional level. As in McDougall et al. (2005) which highlight the local government as a source of detailed information for SDIs. The authors report that in Australia, despite that the policies are established at the national level, its understanding, acceptance and implementation at the local level

varies greatly. They conclude that partnerships should be strengthened in order to maintain a more equal relationship between the different levels.

2.2. The NSDI and its Action Plan

The National Spatial Data Infrastructure in Brazil (NSDI) was established in 2008 through the decree number 6,666. This decree, besides defining the goals of the initiative and establishing key main concepts and responsibilities, also set a deadline of 180 days for the National Commission of Cartography (CONCAR) to write a detailed Action Plan (CONCAR, 2010) for the implementation of the NSDI. Thus, the Action Plan defined three implementation cycles and established a number of Working Groups (WG). Among them is the Capacity Building WG which is responsible for drafting the Training Plan Chapter and subsequently for coordinating its implementation.

Cycle I is the initial phase of the NSDI-BR implementation, originally planned to last one year, in which all federal actors should be involved. In this phase was scheduled the definition of content, the establishment of educational material and the instructors training. Currently the NSDI webpage include a geospatial data viewer which comprises WMS from three institutions: Brazilian Institute of Geography and Statistics (IBGE), Ministry of Planning (MP) and Ministry of Social Development (MDS). Indeed, even the federal institutions aimed in Cycle I are not yet integrated, and one of the main reasons of low compliance is the lack of well-trained staff to publish such services in the institutions that will compose the nodes of the Brazilian Directory of Geospatial Data (DBDG).

The Cycle II, yet to be started, is expected to last two years, and will include the infrastructure consolidation, its extension to other levels of government (state and municipal) and a greater coordination with global initiatives. The next cycle, scheduled to last five years, intends to integrate other non-governmental sectors of society.

The Action Plan highlights the valuation and investment in the individual as a central point in structuring the NSDI. It also defines a number of roles played by NSDI's actors, which include: strategic management, acquisition and publication of data and metadata, geoservices maintenance and users in general.

The document also emphasizes the needs assessment: who to train, how, in which, by whom, where, when and for what. To date, there is still a general overview of who to train and a general outline of the content, but many of the questions above remain unanswered. In the Action Plan, Distance Education is brought to attention in a separate chapter.

The Capacity Building WG has been meeting since 2010 to define the educational modules and their main content for the NSDI training. The main focus initially comprises the training of actors from the federal government in order to speed up the integration of their institutions to the NSDI, but no detailed surveys were conducted until now to assess the demand for training and to measure the needs in terms of the number of instructors and other resources.

2.3. Survey of the demand for NSDI Capacity Building in Parana State

The Federal University of Paraná (UFPR) is the oldest Brazilian University, with one of the first Cartographic Engineering programs, created in 1977, with a total of 561 graduates. It is also the largest public high education institution in the state, offering 6.429 new places a year, 329 programs, from which 19 are distance education, totalizing 32.969 students (UFPR, 2010). Considering the target students in undergraduate programs as Cartographic Engineering (229), Environmental Engineering (260) and Geography (297), we have around 786 students currently at UFPR that could attend NSDI-related courses.

Concerning professionals already working in private sector, there are 53 private companies producing geospatial information that are members of Aerosurveying National Companies Association (ANEA) and registered in Defense Ministry in Brazil. Among then, 12 are located in Paraná State, the second largest state in this sector. There are an estimated number of 800 technicians working on these companies. To calculate the number of the professionals working in other companies, we considered professionals registered in the Regional Architecture and Engineering Council (CREA-PR) in related fields: Cartographic Engineers, Surveying Engineers, Environmental Engineers, Geographers and technicians in Surveying, which adds more 1178 professionals, summarizing estimated 2000 technicians in private sector in the state.

The universe should also consider not only students and private sector employees but also those professionals in state and local government working with geospatial data production.

In the local government level, the number of employees to attend NSDI capacity building programs was estimated accordingly to the city´s population in IBGE Census 2010. The results are shown on T*able 2*:

Population Class	Municipalities	Estimated number of	Total

	(Paraná State)	professionals	
More than 1,000,000 inhabitants	1	10	10
Between 100,000 and 1,000.000 inhabitants	18	5	90
Between 20,000 and 100,000 inhabitants	42	2	84
Less than 20,000 inhabitants	338	1	338
	399		522

Table 2: Training Estimative for NSDI According Municipal Population Source: IBGE (2010)

For the state level the number of professionals, including geospatial information users and producers, the source was the Paraná State Cartography Survey, conducted by the Technical Chamber of Cartography and Geoprocessing of the state, entity that aggregates the state government actors in this field. The survey identified the main public institutions that produce, hire, use or manage geospatial information. In this case, professionals considered were not only the ones listed before, but also the analysts in charge of Communication and Information Technology that works in this area. The following *Table 3* represents the number of professionals in each institution:

Institution	Current Professionals	Capacity Building Target Estimative
Energy Company of Paraná (COPEL)	8549	70
Water and Sanitation Company of Paraná (SANEPAR)	6869	12
Communication and Information Technology Company of Paraná (CELEPAR)	1064	15
Curitiba Metropolitan Area Coordination (COMEC)	38	4
Parana State Road Department (DER)	2297	4

Parana State Environmental Institute (IAP)	627	13
Parana State Water Institute (AGUASPR)	206	2
Land, Cartography and Geosciences Institute (ITCG)	62	9
Parana State Technical Assistance and Rural Extension Institute (EMATER)	133	5
Parana State Economical and Social Development Institute (IPARDES)	132	18
SIMEPAR Institute of Technology	50	4
Itaipu Binacional (hydroelectric dam)	1458	2
State Secretary of Food and Agriculture (SEAB)	1060	2
State Secretary of Education (SEED)	142698	15
State Secretary of Public Safety(SESP)	24512	1
State Secretary of Infrastructure and Logistics(SEIL)	122	3
State Secretary of Urban Development (SEDU)	70	6
State Secretary of Environment and Water Resources (SEMA)	89	2
Parana State Geological Service (MINEROPAR)	49	3
PARANACIDADE Social Service	110	11
	190195	201

Table 3: Training Estimative for NSDI According State Institutions Source: Portal da Transparência-PARANÁ,2012 and CREA ,2012

Considering all sectors, we estimate about 786 students, 2000 private sector professionals, 522 local government employees and 201 state level technicians, totalizing around 3500 individuals potentially interested from diverse backgrounds. Therefore, there are many challenges concerning the human resource development to structure the NSDI. These resources are essential to establish and correctly use the standards that will affect data,

metadata and services, and to implement the Brazilian Geospatial Data Directory and the Portal SIG Brasil.

In contrast with other countries where geospatial data production and dissemination is well defined, standardized, organized, consistent and with well-known quality parameters, Brazil, as other Latin American countries still lacks from standardization and technical specifications regarding cartographic products. The current legislation are from 1967 (Guidelines and Bases of Brazilian Cartography) and 1984 (Technical Standards of the National Cartography). Therefore, it can be observed the lack of an updated National Geoinformation Policy and the lapses in the National Cartographic Plan that imply in portions of national territory still missing basic mapping and the general issues of insufficient topographic updating (CAMBOIM and SLUTER, 2009). In addition, as the standards are not available or disseminate, other datasets are often produced in a heterogeneous manner, concerning scales, symbology and theme choices.

Thus, the importance to create the workforce to produce and disseminate geospatial information and data in Brazil is vital to allow effective contribution about geographic knowledge of the national territory, in all scales and themes.

3. The role of Federal University of Paraná (UFPR) in NSDI capacity building initiative.

3.1. The role of Universities in NSDI capacity building courses

The Article 207 of the 1988 Brazilian Constitution established that the universities should follow the principle of integration of teaching, research and extension. Therefore, further than include NSDI topics in undergraduate and graduate curricula, other activities can also be developed by high education institutions.

In research activities, the Universities have the key role to act in scientific and technological issues that are vital to structure such an initiative, with many challenges regarding both content and management. Other important opportunity is to collaborate in national and international standardization processes and to participate in the area's policy making discussions.

The universities have also the purpose to act promoting the connection between the knowledge produced and the society in general, through extension activities. These activities facilitate the academic world to approach the professional community and allow teaching for a wider audience then students and researchers.

The universities and research institutes during the NSDI Action Plan creation where separated in its own module of Capacity Building. On that time, there was yet no perception that when preparing content to prepare future professionals, the universities could also contribute with the training of the current workforce.

In a way to engage academic field in the project, on September, 2012, the National Cartographic Commission (CONCAR) promoted an event in Brasilia with representative of several universities that already have teaching or research activities in geospatial information to discuss the role of academy in NSDI. Many experiences were shared during the meeting, which ended with the task to build an academic network to support integration and knowledge exchange, in order to consolidate the role of university, including in Capacity Building issues. Some professors are also part of the Capacity Building WG and are contributing actively with the module's outlines and content creation. The insertion of NSDI topics in the universities curricula, although, is not integrated and it is been created in distinct formats in each institution.

3.2. The creation of a Open Geospatial Laboratory at UFPR

The International Cartographic Association and the Open Source Geospatial Foundation are together promoting the creation of Open Source Geospatial Laboratories and Research Centres around the world. These laboratories have the objective to support the development of open source geospatial software and data.

Currently more than 11 laboratories are established or in processes of establishment, on all continents. This is an opportunity to be part of a global network that can support the exchange of knowledge and experiences among distinct realities. The main focus of the network, open software, data and standards are also at the core of NSDI development.

The first activity to create the laboratory at UFPR was to get approval from the Geomatics Department, which occurred during a meeting on May, 2012. The next step was to write a project to receive financial support from the University to set up the physical structure and the portal, which was granted on September, 2012. The other planned activities in the project are:

1. Develop Partnerships – In this phase, the objective is to contact other institutions that can contribute with the website content, and analyze potential demand for courses in the community. Also in this activity, we plan to search partner projects and funding sources that can be interested in both online and in situ courses.
2. Crate and adapt content, focusing in local examples.

3. Create a platform for e-learning – this step include the development of the website that will host the information available, and the progressive construction of a boarder platform that could deliver distance learning resources. A wiki platform will be provided also, to help the collaborative creation of resources.
4. Promote the use of Open Source in the Department Courses. – Integration of Open Source technology in the existent courses of the Undergraduate and Graduated programs.
5. Focus on instructors training – to assure that more agents are enabled to multiply the knowledge in their cities and institutions.

3.3. Content outline

The capacity building process comprehends four levels of behavioral changes, from the simpler to the more complex: information transmission, development of skills, development of attitudes and development of concepts (CINDE, 2010). The process is a cycle that involves diagnosis, training strategies development and implementation and subsequently evaluation and control.

In the Action Plan the general outline of training was defined by professional profiles and institutional positions. Five classes were identified: technical management, information technology professionals, geosciences professionals, educators (basic, technical and superior levels) and general users. Among them it is still to be identified the ones that will act as knowledge multipliers in their respective organizations.

The Capacity Building content was structured in modules, including topics of distinct complexity that can be combined in order to achieve several user groups. This strategy allows the flexibility of adapting the content accordingly with the users profiles and lead to better analysis of the resources needed for each situation. However, the creation of modules ranging from every aspect of NSDI operation is an extensive task that is extremely time-consuming.

The idea to delineate the Open Geospatial Lab – UFPR target content is to choose, from the general description of NSDI modules in the Action Plan, those topics that are also in line with the Open Geospatial network, the local academic expertise and the Paraná State knowledge demand, among them:

- Open Source software to: geospatial data production, geoservices creation and publishing, metadata management and dissemination, geographic databases and interactive thematic mapping creation.

- Open Standards: ISO TC/211, OGC and NSDI-specific standards (Brazilian Metadata Profile, National Topographic Mapping Model – ET-EDGV, among others).
- Open Data: legislation, data sources, formats and mash-ups.
- General SDI introduction.

3.4. Target Public and Format Definition

Using the previous estimates of demand in Paraná State (item 2.4), the target professionals to reach is around 2000, and of students at UFPR, 800. This is a large public that is distributed over the state territory, not only in Curitiba, the capital. The option for online teaching is considered important, analyzing basically the structure existent, the urgency of the matter and the availability of the professionals to be trained.

The detailed outline for each scenario depends on each institution's needs, previous knowledge, available resources, content and teaching modality (in situ or online).

The first phase of the process is to raise awareness to NSDI culture, focusing the comprehension of concepts, principles and fundamental aspects. After that, accordingly to the local interest, the subsequent modules could be applied and consequently the expansion the capacity building at regional level.

4. Conclusion

The NSDI is now perceived as essential to Brazilian government and society. One important obstacle achieving the goals established in the Action Plan is to have a well-prepared workforce in order to produce, publish and use the geospatial information accordingly to SDI principles.

Since much of the data is created and handled at local and regional level, and Brazil has a great regional diversity, the network of high education institutes is one suitable option to act in the different states bringing NSDI national outlined contents to each local reality and examples. Further, the distance learning techniques can support this development to be even more distributed and in the speed needed to have the initiative operational in a near future.

The Open Geospatial Laboratory network supported by International Cartographic Association and the Open Source Geospatial Foundation can be a great opportunity to help Brazilian universities to prepare for this challenge and contributing to the nodes not feel that are starting from scratch but learning with each other experiences.

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